c) measurement error; and

d) deterioration in service between maintenance periods.

The words "receiving equipment" as used in this section, include the receiver itself, the antenna(s) and the necessary inter-connexions in the aircraft.

2.2.1 *General*

2.2.1.1 In order to ensure consistent and reliable operation, the output characteristics of the receiver in respect of course line (centring) and course width (deflection) should be maintained to a degree of accuracy appropriate to the operational objective. Attention is directed towards the need to take into account the variable conditions that may affect such accuracy.

2.2.1.2 Furthermore, in order to ensure that a constant course width is realized by all users of the ILS system, it is necessary to standardize the over-all gain of the localizer receiver. Similar considerations apply in the case of the glide path receiver.

2.2.2 *Localizer receiver audio gain adjustment*

2.2.2.1 The audio gain of the receiver should be such that, with a radio frequency input of 1 000 microvolts modulated 20 per cent by a 90 Hz tone and 20 per cent by a 150 Hz tone, a zero indication is achieved and that, upon a simultaneous increase in one component of 4.65 per cent (i.e. to 24.65 per cent) and a decrease in the other component of 4.65 per cent (i.e. to 15.35 per cent), there is a proportional deflection of 3/5 of the full course width indication but not less than 9.5 mm along its scale. This gain adjustment is to be made with the normal power supply voltage encountered under airborne operating conditions.

2.2.3 *Localizer receiving equipment centring tolerance*

2.2.3.1 To obtain the operational objectives associated with ILS Performance Categories I, II and III and to assure the safe operation of aircraft within the obstacle clearance surfaces, the centring error of the receiving equipment, operating within all the likely aircraft environmental conditions and receiving a zero signal (DDM) within the limits of the ground equipment radio frequency modulation characteristics and identification tolerances, as specified in Part I, 3.1.3 and with an RF field strength of 90 microvolts per metre (minus 107 dBW/m²), should not exceed the following limits with a 68 per cent probability:

Category I: 4.66 per cent of the full course width indication (0.0072 DDM)

Category II: 2.33 per cent of the full course width indication (0.0036 DDM)

Category III: 1.66 per cent of the full course width indication (0.00258 DDM)

Note.— These requirements should also be met at larger field strengths up to the maximum field strength likely to be encountered in operational service.

2.2.4 *Localizer course displacement sensitivity (deflection) tolerance*

2.2.4.1 When the receiver audio gain has been adjusted in accordance with 2.2.2 above, and with an increase in one modulation tone of the audio frequency input signal of 4.65 per cent with respect to the nominal value (i.e. 24.65 per cent) and a simultaneous decrease of the other component by 4.65 per cent with respect to the nominal value (i.e. 15.35 per cent), the indicated deflection signal should not vary more than plus or minus 0.019 DDM from the nominal value at a signal strength of 90 microvolts per metre (minus 107 dBW/m²) up to the maximum field strength likely to be encountered in operational service.

Note.— See 2.2.5 below in respect to signal levels.

2.2.5 *Localizer receiving system minimum signal level sensitivity*

2.2.5.1 The sensitivity of the localizer receiving equipment should be such that in a high percentage of cases, the receiver should indicate a usable signal and a substantially steady indication in the presence of the minimum field strength specified in Part I, 3.1.3.3.2 (40 microvolts per metre or minus 114 dBW/m²).

Note 1.— The maximum signal level likely to be encountered under 2.2.3 and 2.2.4 above is 500 microvolts. Signal levels on the order of 5 000 microvolts may be encountered in the near vicinity of the transmitter (e.g. when flying over the localizer during a missed approach, or when the localizer is used for rollout or take-off guidance).

Note 2.— The two levels of sensitivity addressed in 2.2.4 and 2.2.5 above ensure:

a) a high quality output such as is necessary for approach purposes; and

b) an output of lesser quality adequate for operational usage of the facility in other parts of the coverage volume.

Note 3.— The proper operation of the localizer receiving system in the presence of the specified minimum field strength should occur independent of the orientation of the aircraft longitudinal axis in the horizontal plane when the aircraft is exposed to roll angles of 20 degrees and pitch angles of 10 degrees.

2.2.6 *Localizer course displacement linearity*

2.2.6.1 The receiver output course displacement signal should be a substantially linear function of the DDM of the receiver input signal. For any input over the range of plus or minus 0.155 DDM, and for any RF signal level likely to be

encountered in operational service, the displacement sensitivity should not depart from the nominal DDM/deflection ratio defined in 2.2.2 above by more than plus or minus 20 per cent. Also for an input signal of plus or minus 0.165 DDM or greater, the output must be greater than full course displacement.

Note.— See 2.2.5 above in respect to signal levels.

2.2.7 *Localizer receiver bandwidth*

2.2.7.1 The receiver bandwidth should be such as to provide for the reception of channels having the characteristics defined in Part I, 3.1.3.2.1 after taking suitable account of appropriate receiver tolerances.

2.2.8 *Setting of localizer receiver capture level for automatic flight control*

2.2.8.1 With reference to Notes 1 and 2 of Part I, 3.1.3.7.4, it is desirable to set the localizer capture level of automatic flight control systems not above 0.175 DDM. This would allow high speed aircraft to execute large angle intercepts at operationally desirable distances without experiencing nuisance switching effects, provided the criteria for the ground installation in the above-mentioned paragraph are met.

2.2.9 *Localizer receiver susceptibility to VOR and localizer signals*

2.2.9.1 The receiver design should provide correct operation in the following environment:

a) the desired signal exceeds an undesired co-channel by 20 dB or more;

b) an undesired signal, 50 kHz removed from the desired signal, exceeds the desired signal by up to 34 dB. (During bench testing of the receiver, in this first adjacent channel case, the undesired signal is varied over the frequency range of the combined ground station (plus or minus 9 kHz) and receiver frequency tolerance);

c) an undesired signal, 100 kHz removed from the desired signal, exceeds the desired signal by up to 46 dB;

d) an undesired signal, 150 kHz or further removed from the desired signal, exceeds the desired signal by up to 50 dB.

Note 1.— It is recognized that not all receivers currently meet requirement b); however, all future equipments should be designed to meet this requirement.

Note 2.— In some States, a smaller ground station tolerance is used.

2.2.10 *Immunity performance of ILS receiving systems to interference from VHF FM broadcast signals*

2.2.10.1 With reference to the Note of 3.1.4 of Part I, the immunity performance defined there must be measured against an agreed measure of derogation of the receiving system's normal performance, and in the presence of, and under standard conditions for the input wanted signal. This is necessary to ensure that the checking of receiving station equipment on bench test can be performed to a repeatable set of conditions and results and to facilitate their subsequent approval. Tests have shown that FM interference signals may affect both course guidance and flag current, and their effects vary depending on the DDM of the wanted signal which is applied. An adequate measure of immunity performance may be obtained by the use of a wanted signal level of minus 86 dBm with the DDM adjusted to give standard deflections between 5 and 180 microamps. With these conditions the change in course deflection current due to the interfering signal should not exceed 10 per cent of the standard deflection when the levels quoted in 3.1.4.1 and 3.1.4.2 of Part I are applied. The broadcast signals should be selected from frequencies in the range between 87.5 and 107.9 MHz and should be modulated with the representative broadcast type signal.

Note 1.— The signal level of minus 86 dBm assumes a combined antenna and feeder gain of 0 dB.

Note 2.— The change of 10 per cent quoted above is for the purpose of standardization when checking that receiving station equipment on bench measurements meet the required immunity. In the planning of frequencies, and in the assessment of protection from FM broadcast interference, a value not exceeding this, but in many cases lower, depending on the operational circumstances in individual cases, should be chosen as the basis of the interference assessment.

2.2.11 *Glide path receiver audio gain adjustment*

2.2.11.1 The audio gain of the receiver should be such that, with a radio frequency input of 600 microvolts modulated 40 per cent by a 90 Hz tone and 40 per cent by a 150 Hz tone, a zero indication is achieved and that, upon a simultaneous increase in one component of 5.25 per cent (i.e. to 45.25 per cent) and a decrease in the other component of 5.25 per cent (i.e. to 34.75 per cent), there is a proportional deflection of 3/5 of full course width indication but not less than 9.5 mm along its scale. This gain adjustment is to be made with the normal power supply voltage encountered under airborne operational conditions.

2.2.12 *Glide path receiving equipment centring tolerance*

2.2.12.1 To obtain the operational objectives associated with ILS Performance Categories I, II and III and to ensure the safe operation of aircraft within the obstacle clearance surfaces, the centring error of the receiving equipment, operating within all likely aircraft environmental conditions and receiving a zero signal (DDM) within the limits of the ground equipment radio frequency and modulation characteristics tolerances as specified in Part I, 3.1.5, and with

an RF field strength of 400 microvolts per metre (minus 95 dBW/m²), should not exceed the following limits with a 68 per cent probability:

Category I: 5.33 per cent of the full course width indication (0.0093 DDM)

Category II: 3.33 per cent of the full course width indication (0.0058 DDM)

Category III: 3.33 per cent of the full course width indication (0.0058 DDM)

Note.— These operational requirements should also be met at larger field strengths up to the maximum field strength likely to be encountered in operational services.

2.2.13 *Glide path course displacement sensitivity (deflection) tolerance*

2.2.13.1 When the receiver audio gain has been adjusted in accordance with 2.2.10 above and with an increase in one modulation tone of the radio frequency input signal of 5.25 per cent (i.e. to 45.25 per cent) and a simultaneous decrease of the other component of 5.25 per cent (i.e. to 34.75 per cent), the displacement signal should not vary more than plus or minus 0.016 DDM from the nominal value at a signal strength of 400 microvolts per metre (minus 95 dBW/m²) up to the maximum field strength likely to be encountered in operational service.

Note.— See 2.2.14 below in respect to signal levels.

2.2.14 *Glide path receiving system minimum signal level sensitivity*

2.2.14.1 The sensitivity of the glide path receiving system should be such that in a high percentage of cases, the receiver should indicate a usable signal and a substantially steady indication in the presence of the minimum field strength specified in Part I, 3.1.5.3.2 (400 microvolts per metre or minus 95 dBW/m²).

Note 1.— The maximum level of signal likely to be encountered under 2.2.12 and 2.2.13 above is 2 500 microvolts. This signal level occurs when the aircraft is at the runway threshold.

Note 2.— The two levels of sensitivity addressed in 2.2.13 and 2.2.14 ensure:

a) a high quality output such as is necessary for approach purposes; and

b) an output of lesser quality adequate for operational usage of the facility in other parts of the coverage volume.

Note 3.— The proper operation of the glide path receiving system in the presence of the specified minimum field strength should occur also if the aircraft longitudinal axis is varied plus or minus 10 degrees in the horizontal plane together with 20 degrees roll about the localizer course line and also plus or minus 10 degrees pitch in the vertical plane about the horizontal plane.

2.2.15 *Glide path displacement linearity*

2.2.15.1 The receiver output glide path displacement signal should be a substantially linear function of the DDM of the receiver input signal. For any input over the range plus or minus 0.175 DDM, and for any RF signal strength likely to be encountered in operational service, the displacement sensitivity should not depart from the nominal DDM/deflection ratio defined in 2.2.11 above by more than plus or minus 20 per cent. For an input signal of 0.185 DDM or greater, the output must be greater than full course displacement.

Note.— See 2.2.14 above with respect to signal levels.

2.2.16 *Glide path receiver bandwidth*

2.2.16.1 The receiver bandwidth should be such as to provide for the reception of channels having the characteristics defined in Part I, 3.1.5.2.1 after taking suitable account of appropriate receiver tolerances.

2.2.17 *Glide path receiver susceptibility to glide path signal*

2.2.17.1 The receiver design should provide correct operation in the following environment:

a) the desired signal exceeds an undesired co-channel signal by 20 dB or more;

b) an undesired glide path signal, 150 kHz removed from the desired signal, exceeds the desired signal by up to 20 dB. (During bench testing of the receiver, in this first adjacent channel case, the undesired signal is varied over the frequency range of the combined ground station (plus or minus 17 kHz) and receiver frequency tolerance);

c) an undesired glide path signal, 300 kHz or further removed from the desired signal, exceeds the desired signal by up to 40 dB.

Note 1.— It is recognized that not all receivers currently meet requirement b); however, all future equipments should be designed to meet this requirement.

Note 2.— In some States, a smaller ground station tolerance is used.

2.2.18 *Localizer and glide path receiver effect from vertical polarization*

2.2.18.1 Over the localizer and glide path frequency bands, respectively, the reception of vertically polarized signals from the forward direction with respect to the localizer and glide path antenna should be at least 10 dB below the

reception of horizontally polarized signals from the same direction.

2.2.19 *Localizer and glide path receiver spurious response*

2.2.19.1 The response (indicator deflection) of the localizer receiver to a 150 Hz 30 per cent modulated RF signal at 110 MHz should be greater than the response to a similarly modulated but 60 dB greater amplitude RF signal varied over 90 kHz to 107.8 MHz and 112.2 MHz to 1 500 MHz. The response of the glide path receiver to a 150 Hz 30 per cent modulated RF signal at 332.0 MHz should be greater than the response to a similarly modulated but 60 dB greater amplitude RF signal varied over 90 kHz to 329.0 MHz and 335.3 MHz to 1 500 MHz.

2.3 Malfunctioning alarm in ILS airborne equipment

2.3.1 Ideally, a receiver alarm system such as a visual mechanical flag should warn a pilot of any unacceptable malfunctioning conditions which might arise within either the ground or airborne equipments. The extent to which such an ideal may be satisfied is specified below.

2.3.2 The alarm system is actuated by the sum of two modulation depths and, therefore, the removal of the ILS course modulation components from the radiated carrier should result in the actuation of the alarm.

2.3.3 The alarm system should indicate to the pilot and to any other airborne system which may be utilizing the localizer and glide path data, the existence of any of the following conditions:

a) The absence of any RF signal as well as the absence of simultaneous 90 Hz and 150 Hz modulation.

b) The percentage modulation of either the 90 Hz or 150 Hz signal reduction to zero with the other maintained at its normal 20 per cent and 40 per cent modulation respectively for the localizer and glide path.

Note.— It is recommended that the localizer alarm occur when either the 90 Hz or 150 Hz modulation is reduced to 10 per cent with the other maintained at its normal 20 per cent. It is recommended that the glide path alarm occur when either the 90 Hz or 150 Hz modulation is reduced to 20 per cent with the other maintained at its normal 40 per cent.

c) The receiver off-course indication 50 per cent or less of that specified when setting the receiver audio gain adjustment (see 2.2.2 and 2.2.11 above).

2.3.3.1 The alarm indication should be easily discernible and visible under all normal flight deck conditions. If a flag is used, it should be as large as practicable commensurate with the display.

2.4 Guidance for the siting, elevation, adjustment and coverage of glide path equipment

2.4.1 The ILS reference datum and the ILS glide path angle setting are the primary factors influencing the longitudinal location of the ILS glide path equipment with respect to the threshold.

2.4.2 The lateral placement of the glide path antenna system with respect to the runway centre line should not be less than 120 m (400 ft). In deciding the lateral placement of the glide path antenna, account should be taken of the appropriate provisions of Annex 14 with regard to obstacle clearance surfaces and objects on strips for runways.

2.4.3 In selecting the ILS glide path antenna location and glide path angle, the aim should be to place the ILS reference datum as close as possible to the appropriate nominal value. The actual selection of the ILS glide path antenna location and glide path angle are governed by a number of factors, including:

a) acceptable rates of descent and/or approach speeds for the type of operations envisaged at the particular aerodrome;

b) the position of obstacles in the final approach area, the aerodrome sector and the missed approach area, and the resulting obstacle clearance limits;

c) technical siting problems.

2.4.4 The selection of the antenna location and the angle, and the resulting ILS reference datum height, will also be affected by:

a) the runway length available;

b) the operating limits envisaged.

Where the application of the foregoing criteria permits, the preferred angle of the ILS glide path would be 3 degrees.

2.4.5 An ILS reference datum and glide path should then be selected, having regard to the foregoing criteria, and the ability of the site to provide the clearance required by the *Procedures for Air Navigation Services — Aircraft Operations* (PANS-OPS, Doc 8168) should be determined by calculation and confirmed, where possible, by flight test.

2.4.6 Where the selected ILS reference datum, the ILS glide path angle and the other relevant equipment characteristics do not provide the required clearances, the following alternative course of action should be investigated:

1) removal of the offending obstacle;

2) selection of an alternative height for the ILS reference datum, taking into account the criteria indicated in 2.4.3 and 2.4.5 above;

3) selection of an alternative acceptable ILS glide path angle.

CERTIFICATE OF SERVICE

I hereby certify that on this 11th day of March, 1991, a copy of the foregoing Comments of Robert C. Beckham In the Matter of Request for Rulemaking setting standards for Aviation Receivers has been served by United States mail, postage prepaid, upon the following:

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